Reactive Hydrocarbon Analyzer

Subcontractor

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Objective

To examine the potential for directly monitoring hydrocarbon (HC) class reactivity by using the temperature dependence of ozone (O_3) chemiluminescent reactions.

Approach

Presently, HC reactivity is determined by using non-methane hydrocarbon (NMHC) analyzers or gas chromatography/mass spectroscopic (GC/MS) methods. NMHC is nonspecific and uses a flame ionization detection system that yields only the amount of carbon emitted. GC/MS is expensive, time consuming, and does not lend itself to real-time measurements of automotive exhaust or ambient HC levels. This project uses the temperature dependence of O_3 chemiluminescent reactions that correlate directly with hydroxy radical (OH) reactivities to separate HC class signals. The olefin signal occurs at room temperature and is surrogated as a class by using propylene. Aromatics chemiluminesce at approximately 70°C and toluene is being used as a surrogate. Alkanes react with O_3 to produce light at temperatures higher than 120°C. This approach is being examined and compared to flame ionization detection (FID) as a potential method for direct on-line measurement of HC classes.

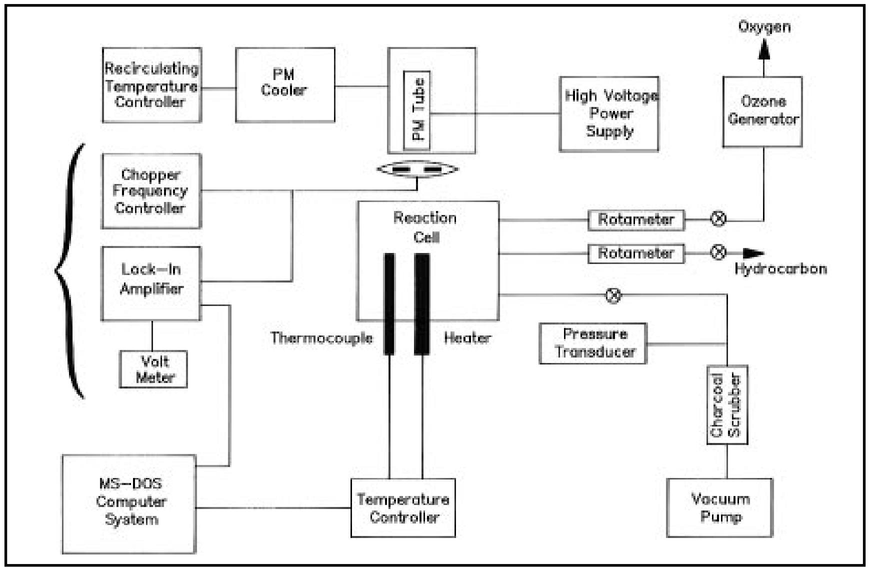


Diagram of hydrocarbon monitor

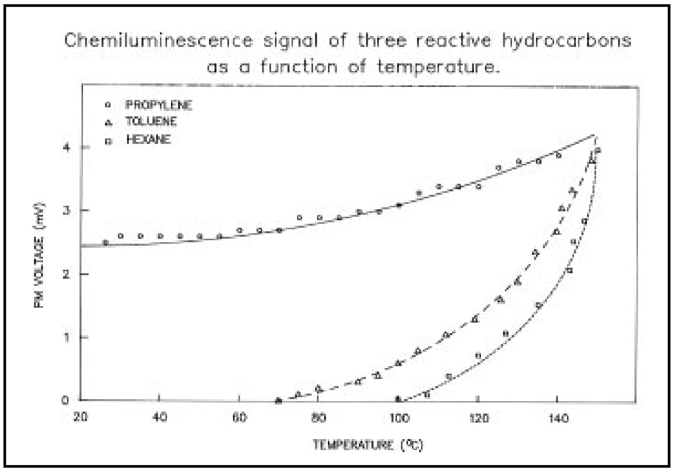
Accomplishments

A prototype temperature-dependent O_3 chemiluminescent HC analyzer has been designed and built.

Preliminary testing has shown the propylene, toluene, and n-hexane surrogates can be distinguished as a function of temperature. Other preliminary studies have shown that a prereaction chamber can be used to scrub out the more reactive olefins from the less reactive aromatics. The detection system is a potentially selective and sensitive GC monitoring technique for natural HCs and other reactive HCs.

Future Direction

We will perform short-term studies that compare the response of the O_3 chemiluminescent detection system at high temperature (120°–150°C) to that of a conventional FID system. A mixture of various reactivity olefins, aromatics, and alkanes will be analyzed by both the chemiluminescent detection system and the standard flame detector after GC separation. Depending on the results of these studies, this project will pursue prereactor studies and possible technology transfer interactions with the instrument industry to develop this method for use in the automotive industry and in air quality monitoring.



Publications

Gaffney, J.S. and N.A. Marley. 1993. "Reactive Hydrocarbon Analyzer; Effects of Ethanol Fuel on Urban Air Quality." Status Report presented at the Joint Meeting of the CRC-APRAC Atmospheric Chemistry Group and Reactivity of Vehicle Emissions Group. University of California, Riverside, College of Engineering, Center for Environmental Research and Technology, November 2–3.

Gaffney, J.S., N.A. Marley, and M.M. Cunningham. 1994. "Reactive Hydrocarbon Class Determination Using the Temperature Dependence of Ozone Chemiluminescent Reactions." Paper No. 425, presented in the Session on Spectroscopic Solutions to Environmental Problems, PITTCON '94, Chicago, Illinois, February 27–March, 1994.

Gaffney, J.S. 1994. "Progress Report on the Reactive Hydrocarbon Analyzer Based on Ozone Chemiluminescence." Coordinating Research Council Review, Detroit, Michigan, October 6.

Gaffney, J.S. and N.A. Marley. 1994. "A Reactive Hydrocarbon Analyzer: Based upon Ozone Chemiluminescence." A Final Report on the First Year of Research for the Coordinating Research Council, Inc., Atlanta, Georgia (Project AQ-5) and the National Renewable Energy Laboratory, Golden, Colorado (Project 12252-05). August, Revised October.